GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Basics of Microelectronics, PG_00048079					
Field of study	Electronics and Telecommunications					
Date of commencement of studies	October 2022		Academic year of realisation of subject		2024/2025	
Education level	first-cycle studies		Subject group		Optional subject group Subject group related to scientific research in the field of study	
Mode of study	Full-time studies		Mode of delivery		at the university	
Year of study	3		Language of instruction		Polish	
Semester of study	5		ECTS credits		3.0	
Learning profile	general academic profile		Assessment form		exam	
Conducting unit	Department of Microelectronic Systems -> Faculty of Electronics, Telecommunications and Informatics					
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Piotr Płotka			
	Teachers		dr hab. inż. Piotr Płotka			
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study	SUM
	Number of study hours	30		3.0	42.0	75
Subject objectives	Building of knowledge and skills for selection of a family and of a technology of application specific integrated circuits, appropriately for the required functionality. Building skills for designing basic cells and subcircuits of integrated circuits.					

<table>
<tr><td>Learning outcomes</td><td>

Course outcome	Subject outcome	Method of verification
[K6_U06] can analyse the operation of components, circuits and systems related to the field of study, measure their parameters and examine technical specifications	Student selects an appropriate family of integrated circuits with respect to the required elements, technologies and methods of construction. In relation to the selected family of integrated circuits he applies basic circuit designs and photomask layouts of combinatory subcircuits, flip-flop blocks as well as memory blocks. He synthetizes combinatory circuits. He considers influence of element scaling of integrated circuits on properties of transistors and influence of transistor characteristics on properties of the integrated circuits.	[SU1] Assessment of task fulfilment
[K6_W32] Knows the parameters, functions and methods of analysis, design and optimization of analogue and digital circuits and electronic systems	Student knows properties of the main families of integrated circuits in relation to the applied elements and technologies. He knows basic constructions and element layouts of logical gates and flip-flops in various families of integrated circuits. Student describes main fabrication steps of CMOS and BiCMOS integrated circuits. Student describes main technological processes used in fabrication of integrated circuits. Student describes currently developed technologies which can replace or complement silicon technologies in future.	[SW1] Assessment of factual knowledge
[K6_W33] Knows programming languages and equipment description languages, as well as methods for the synthesis of combinational and sequential circuits and programmable systems	Student specifies basic constructions and element layouts of logical gates in different families of integrated circuits, with respect to parasitic elements. Student specifies basic constructions and element layouts of flip-flops in different families of integrated circuits. Student specifies basic constructions and element layouts of memory cells and blocks in different families of integrated circuits.	[SW1] Assessment of factual knowledge

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<tr><td>Subject contents</td><td>Basic families of integrated circuits - classifications based on application types, devices used for constructions, substrates and technologies. Application specific integrated circuits - full custom, gate arrays, standard cells.
Scaling rules of MOS transistors in integrated circuits. Effect of scaling on operation speed, packing density, power consumption and technological yield.
Extraction of MOS FET model parameters for electrical circuit simulation with programs like SPICE. Special circuits like ring oscillators.
Introduction to photolithography in microelectronics. Advantages and disadvantages of electron beam lithography.
Substrates for fabrication of integrated circuits.
Si oxidation - for fabrication of gates and isolation in CMOS technology.
Selective doping of silicon - diffusion from gas phase and ion implantation.
Etching of materials used in semiconductor technology.
Physical vapor deposition of layers. Properties of metal-semiconductor contacts and of conducting paths.
Chemical deposition, forming and application of layers in semiconductor technology - SiO2, SiN, metals, oxides of high dielectric constants, materials of low dielectric constants. Deposition of layers with a singe atomic layer precision – principles and application of ALD. Example technologies of HfO2, Al2O3, ZrO2.
Epitaxy - contemporary applications in microelectronics.
Device integration in contemporary, advanced MOS technologies. Layout of inverter gate elements, photomask sets and sequences of fabrication steps, including process flows for FinFETs.
Logic gates in silicon technologies: CMOS, BiCMOS, ECL. Construction, operation, element layouts, designing problems. Influence of parasitic elements. Logic gates in IIIV technologies.
Sequential logic circuits in silicon technologies: CMOS, BiCMOS, ECL. Construction, operation, element layouts, designing problems.
Memory circuits of RAM, ROM and FLASH types in silicon technologies: CMOS, BiCMOS, ECL. Construction, operation, element layouts, designing problems. Possibilities of integration of memory circuits with logic circuits.
Integration of devices in amorphic and polycrystalline materials - like for liquid crystal displays and for photovoltaics and optoelectronics.
Integrated circuits in organic semiconductors - properties and methods of fabrication. Prospectives of integration and application.
Prospectives and problems of integration of mesoscopic devices operating with two- one- or zero-dimensional physics. Prospectives of application of new materials like graphen.</td></tr>
<tr><td>Prerequisites
and co-requisites</td><td></td></tr>
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Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Written exam	50.0%	100.0%
Recommended reading	Basic literature	B. Razavi, "Fundamentals of Microelectronics", Wiley, 2006 H. Veendrick, "Nanometer CMOS ICs: from Basics to ASICs", Springer, 2008 R. Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation", Wiley, 2008, - figures, examples, Spice & Cadence models: http://cmosedu.com/cmos1/book.htm	
	Supplementary literature	A.S. Sedra, K.C. Smith, "Microelectronic Circuits", Oxford, 2007 J.C. Whitaker, "Microelectronics", 2nd. ed., CRC Press 2006 B. El-Kareh, "Silicon Devices and Process Integration. Deep Submicron and Nano-Scale Technologies", Springer 2009 N. Collaert, "CMOS Nanoelectronics: Innovative Devices, Architectures, and Applications", Pan Stanford Publ. 2012 G. Cerofolini, "Nanoscale Devices. Fabrication, Functionalization, and Accessibility from the Macroscopic World", Springer 2009 A. Korkin, F. Rosei, "Nanoelectronics and Photonics. From Atoms to Materials, Devices, and Architectures", Springer 2008	
	eResources addresses		
Example issues/ example questions/ tasks being completed	Compare properties of CMOS and BiCMOS integrated circuits. Draw a circuit diagram and a "stick diagram" of a gate implementing in a CMOS technology a logic function of not F = (A and B) or C.		
Work placement	Not applicable		